PROJECT **facts**

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
NATIONAL ENERGY TECHNOLOGY LABORATORY

Petroleum Environmental Solutions

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AIRBORNE REMOTE SENSING OF PRODUCED WATER FROM COALBED NATURAL GAS DEVELOPMENT

Helicopters trace water movement in the Powder River Basin

PARTNERS

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MAIN SITE

Powder River Basin
WY & MT

DOE is using remote sensors suspended from helicopters to map the flow of groundwater.

Background/Problem

The Powder River Basin covers 12,000 sq. miles in Wyoming and Montana. The development of coalbed natural gas (CBNG) resources in the Powder River Basin has resulted in large volumes of produced water that are disposed of on the surface by land application or returned to groundwater aquifers via infiltration basins or injection wells. By 2003 over 26,000 coalbed natural gas wells in Wyoming were producing nearly 1 billion cubic feet of natural gas per day. Along with the coalbed natural gas production, 1.6 million barrels of produced water per day are being brought to the surface. The management of such large volumes of produced water constitutes a major challenge to the oil and gas industry as well as federal and state regulators. In-house research from NETL-Pittsburgh and the University of Pittsburgh is implementing airborne magnetic and electromagnetic surveys of selected active and proposed CBNG areas.

The survey technique uses helicopters to detect near-surface aquifers (depth <150 ft) beneath and adjacent to produced water impoundments. Monitoring the effect of produced water on near-surface aquifers using airborne electromagnetic surveys is an effort to prevent problems and find and correct unfavorable situations. The intent of the survey is to evaluate the use of airborne electromagnetic surveys for large-scale mapping of near-surface aquifers and movement of produced water plumes.

Project Description/Accomplishments

Starting in June 2003, NETL sponsored flyovers to survey approximately 70 sq. miles in the Wyoming portion of the Powder River Basin. Seven surveys were flown in 2003 over proposed and active CBNG areas. In July 2004, portions of two areas were reflown to determine changes in groundwater hydrology that had occurred in response to a year of CBNG activity. Two new areas with in-stream impoundments were flown also. In deployment of the airborne survey, a helicopter flies a prepared grid pattern about 200 feet above the ground. Dangling about 100 feet below the helicopter are two types of sensors, one that can detect wells by the magnetic properties of their steel casing and another that can detect in-ground conductors such as aquifers by the small currents that flow within them. Information from the survey is used to determine well location and the location, depth, and water quality of near-surface aquifers. In conjunction with the airborne survey, ground conductivity surveys are conducted on small subareas of the airborne survey to validate airborne results. Changes in ground conductivity provide a measure of produced water movement in near-surface aquifers.

Airborne Remote Sensing of Produced Water from Coalbed Natural Gas Development

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TOTAL ESTIMATED COST

$1,100,000

COST SHARING

DOE
In-House Funding - $1,100,000

WEBSITE

www.netl.doe.gov

The surveys found that aquifers adjacent to produced water impoundments could be either more conductive or less conductive than non-impacted aquifers, depending on the conductivity of the CBNG water, the conductivity of the native groundwater, and the amount of salts stored in the strata above the water table. For example, the survey detected a highly conductive area below a lined impoundment several months before a leak developed that was visible to ground personnel. Follow-up ground conductivity measurements found that the leaking water was four times more conductive than the produced water in the impoundment, the suspected source of the leaking water. This indicates that the leaking water is either dissolving the salts in the strata through which it is traveling or it is displacing more conductive natural groundwater from these strata. In contrast, low conductivity areas associated with CBNG water were observed at an infiltration basin on the floodplain of the Powder River, which is normally very conductive. This may indicate that at this site, the produced water is diluting the more conductive native groundwater and is actually improving water quality in the near-surface aquifers.

Helicopter electromagnetic surveys were found to rapidly determine the quality of shallow groundwater systems for large areas. This information can identify areas of high quality groundwater so that regulatory agencies can specify a management strategy for produced water that will protect this resource. Likewise, areas of poor quality groundwater can be identified and the produced water can be managed so that the groundwater quality is improved. Further information from electromagnetic surveys can be used to determine the type and location of future impoundments and groundwater monitoring wells.

Benefits/Impacts

Helicopter electromagnetic surveys are a quick, cost-effective way to determine the natural conditions of shallow aquifers prior to CBNG development and to monitor the changes brought about by implementation of various management options for produced water. The ability to map groundwater aquifers and buried river channels will allow more effective placement of groundwater monitoring wells. Aeromagnetic surveys can be used to confirm the locations for existing coalbed natural gas wells, and can identify old wellbores that are not accounted for on state well records and not visible by surface inspection. The study has demonstrated that helicopter electromagnetic surveys can identify potential leaks from lined impoundments several months before seepage is visible on the surface, which allows for more timely correction and remediation.

Ground conductivity survey in the Powder River Basin.